2.0 WATERSHED OVERVIEW

The Lower Fall Creek Watershed is a unique watershed. It drains land from the largest and fastest growing municipalities in Indiana and is rapidly converting from agriculture to urban land uses. This section provides an overview of the physical and social landscape of the Lower Fall Creek Watershed as well as the 3 topics of interest to the Lower Fall Creek Watershed Steering Committee: Land Use and Land Use Change, Groundwater and Surface Water, and Flooding and Flooding Impacts.

2.1 WATERSHED DESCRIPTION

The Lower Fall Creek Watershed drains approximately 57,800 acres (90 square miles) of rural, suburban, and urban land in Central Indiana (**Figure 2-1**). As shown in **Figure 2-2**, this land includes portions of Madison County, Hamilton County (City of Noblesville, Town of Fishers), Hancock County (Town of McCordsville), and Marion County (City of Indianapolis, City of Lawrence). The Lower Fall Creek Watershed consists of 6 14-digit Hydrologic Unit Code (HUC) watersheds. These include: 05120201110-010, 020, 030, 040, 050, and 060.

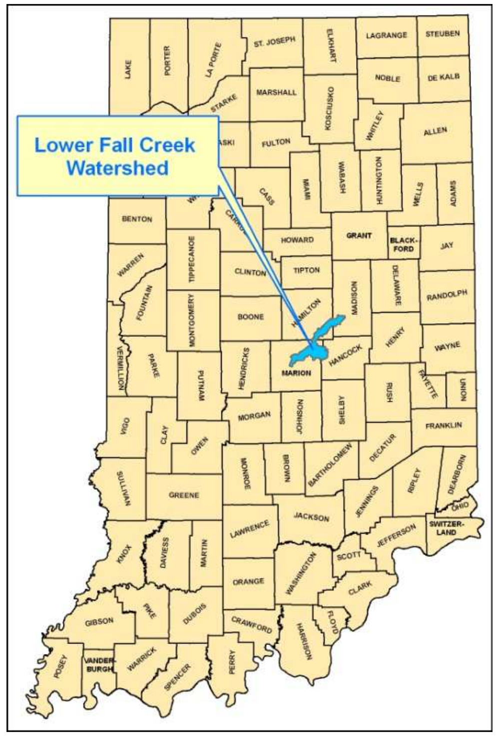


Figure 2-1: Lower Fall Creek Watershed

Physical Landscape

Based on current land use data, 38% of the Lower Fall Creek Watershed is in agriculture production followed by 32% low-density residential development, 20% commercial, industrial, and institutional land uses, 6% open space, 2% golf courses and 2% open water. With the exception of Madison County, the existing agricultural land has been zoned for residential, commercial, or industrial development.

There are 44 publicly-owned parks in the Lower Fall Creek Watershed. This accounts for 6% or 3,250 acres of the land use. The largest of these parks is the 1,700-acre Fort Harrison State Park managed by the Indiana Department of Natural Resources (IDNR). The remaining parklands are owned and operated by Indy Parks, Fishers Parks and Recreation Department, and the Lawrence Parks Department. The Fall Creek Watershed is unique in that much of the land along Fall Creek in Marion County is protected as parkland as was the design in the 1909 Indianapolis Park and Boulevard Plan. This area was added to the National Register of Historic Places in 2003. According to the 2004 Indianapolis-Marion County Parks, Recreation & Open Space Master Plan, the intent of the 1909 Park and Boulevard Plan was to "link the city in a network of transportation and recreation corridors that also function to guide urban growth, conserve the natural environment, limit water pollution, and provide flood control".

In addition to the park areas, natural features in the Lower Fall Creek Watershed provide a home for unique plant and animal species. As shown in **Appendix 4,** there are 78 endangered, threatened, or rare plants and animals that have been identified in Hamilton, Hancock, Madison,

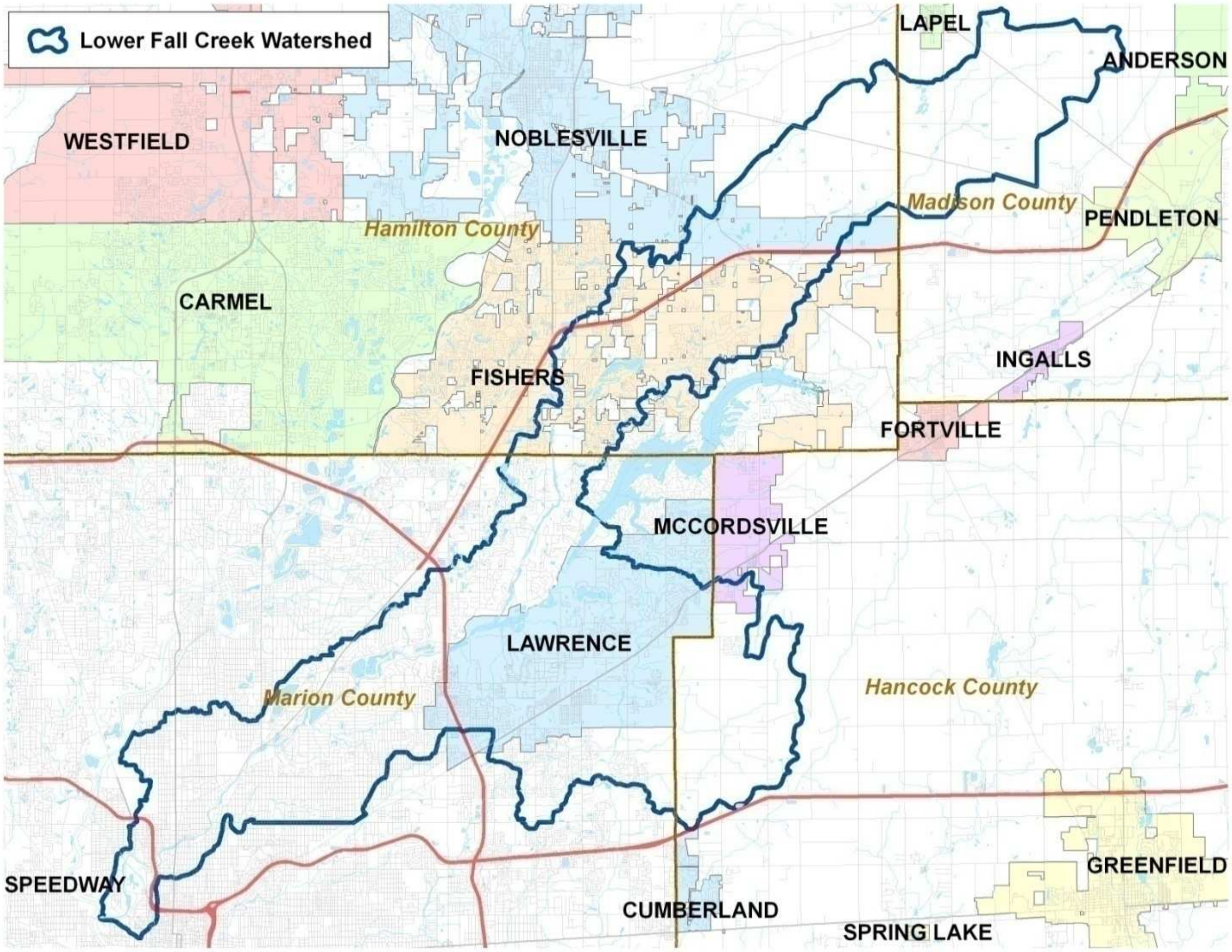


Figure 2-2: Lower Fall Creek Watershed

and Marion Counties. A detailed study to verify whether these plants and animals are located in the Lower Fall Creek Watershed has not been conducted.

The relief and soils of the Lower Fall Creek Watershed were influenced by three glacial periods. As the last of these glaciers retreated, the watershed was scoured to a relatively flat plain with a gently rolling surface, with elevations ranging from approximately 690 to 870 feet above sea level. The more distinctive slopes in the watershed have been formed by the actions of the rivers, streams, and tributaries in the watershed. Some of the greatest relief in the watershed occurs along Fall Creek and Mud Creek in and around the City of Lawrence.

The soils of the Lower Fall Creek Watershed formed from Wisconsin glacial till, glacial outwash, and recently deposited alluvium. According to the Soil Surveys for Hamilton, Hancock, Madison, and Marion Counties, there are 10 predominant soil associations in the Lower Fall Creek Watershed. In the low-lying, floodplain areas, the Genesee-Sloan and Shoals–Genesse associations dominate; whereas in the upland areas, the Crosby-Brookston associations are more prevalent.

There are approximately 126 miles of waterways in the Lower Fall Creek Watershed. These waterways are identified in **Table 2-1** and illustrated in **Exhibit 2-1**. In addition to these waterways there are numerous subsurface drains, storm sewer systems, and other man-made conveyance systems that drain the Lower Fall Creek Watershed.

Within the Lower Fall Creek Watershed there are several lakes and ponds that may also have impacts on the water quality and quantity in the area. These lakes and ponds can have a direct connection to Fall Creek or tributaries via inlets and outlets to and from these water systems. Further, some lakes and ponds were constructed through sand and gravel mining practices and are located in the recharge zones of wellfields utilized to provide drinking water to a high percentage of the population of central Indiana. These lakes and ponds are listed in Table 2-1 and located on Exhibit 2-1; however many are unnamed.

Table 2-1: List of Named Waterbodies

Alexander Hare Drain	George Burke Drain	Mud Creek
Atkinson Creek	Heinrich Ditch	Nancy Kimberlin Drain
Bartholomew Irwin Drain	Henry Ditch	Newton Teter Drain
Bells Run	Henry Ebbert Drain	O'Brien Ditch
Berkshire Creek	Hillcrest Creek	Osborn Ditch
Billings Creek	Hoss Creek	Pistol Run
Blue Creek	Hunter Mitthoefer Ditch	Russell Johnson Drain
Booth and Snead Drain	Indian Branch	Sand Creek
Brave Creek	Indian Creek	Sand Creek Tile Drain
Brian Ditch	Indian Lake	Sarah Morgan Drain
Camp Creek	Indianapolis Water Co. Canal	Schoen Creek
Chime Run	James D. McCarty Drain	Scout Branch
Daniel Heiney Drain	Jay Ditch	Squaw Run
Devon Creek	John Beaver Drain	Stanford Baughm Drain
Dunn Ditch	Kesslerwood Lake (East/West)	Steele Ditch
EE Bennett Drain	Kynett Ditch	Stonebridge Lake
Exit Ten Drain	Laurel Run	TJ Patterson Drain
Fall Creek	Lake Maxinhall	Trittipo Ditch
Field Creek	Margaret Goodwin Drain	Wesley Creek
Fort Branch	Meadows Brook	William McKinstray Drain
Frank Keiser Drain	Minnie Creek	Woollen Run
Garden Run	Mock Creek	

Social Landscape

The Lower Fall Creek Watershed is located in the most populated, and fastest growing, municipalities in Indiana – the City of Indianapolis, Town of Fishers, City of Lawrence, and City of Noblesville. A 2007 Indiana University Kelley School of Business report on the 20 largest cities in 2006, indicated that between 2000 and 2006, the Town of Fishers grew 62.6% (8.1% since 2005), the City of Lawrence grew 7.4% (2.2% since 2005), and the City of Noblesville grew 38.0% (3.3% since 2005). The 2010 growth projections for Hamilton County indicate the county will grow by another 19%, and reach a total population of 298,642. Correspondence with local planning departments confirms that a significant portion of this growth has, and will continue, in the Lower Fall Creek Watershed.

Race and ethnicity vary throughout the Lower Fall Creek Watershed. In the watershed portion of Marion County, 46% of the reporting population is African-American. In comparison, Hamilton, Hancock, and Madison Counties African-Americans account for 3.1%, 1.3%, and 8.1% of each county's respective population. Within the watershed, these populations represent less than 0.5% of the population. Between 1990 and 2000 the Hispanic population has increased between 100% and 200% throughout Marion County and by more than 300% in Hamilton County. However, within the Lower Fall Creek Watershed, the Hispanic population accounts for approximately 2.5% of the population.

As with population and ethnicity, median income and poverty varies throughout the Lower Fall Creek Watershed as well. According to Stats Indiana, Hamilton County had the highest median income ($79,927) and lowest poverty rate (3.9%) in the State followed by Hancock County with a median income of $60,343 (ranked 3rd) and poverty rate of 4.7% (ranked 90th) compared to Marion County's median income of $42,129 (ranked 54th) and poverty rate of 15.2% (ranked 12th) and Madison County's median income of $40,747 (ranked 63rd) and poverty rate of 11.9% (ranked 33rd). **Appendix 5** includes the most recent Stats Indiana profiles for Marion, Hamilton, Madison, and Hancock Counties.

2.2 LAND USE & LAND USE CHANGE

In 2005, the US EPA, with assistance from the American Planning Association (APA) published "Using Smart Growth Techniques as Stormwater Best Management Practices". This landmark publication discusses the nexus between land development patterns and water quality and quantity – especially as it relates to nonpoint source (NPS) pollution. NPS pollution originates when precipitation (rainfall or snowmelt) moves over and through the ground carrying pollutants and then depositing them into lakes, rivers, and aquifers.

Similar studies by the Center for Watershed Protection have illustrated how imperviousness related to land use and land use change can significantly impact water quality. Impervious areas (rooftops, roads, parking lots, driveways, sidewalks, etc.) decrease infiltration and increase the volume and velocity of stormwater runoff. The Center's studies have shown that a stream's ecology begins to degrade with only 10% imperviousness in the watershed. At 25% imperviousness, water quality problems include increases in bacteria concentrations, additions of toxic materials, increases in sediment loads, alterations of water temperature, and reductions in dissolved oxygen concentrations. **Table 2-2** summarizes some of the research completed by the Center for Watershed Protection.

Table 2-2: Impact of Imperviousness on Water Quality

Watershed Imperviousness	Stream Impact	Impact on Water Quality
0-10%	Minimal	Reduced macro invertebrate diversity.
10-15%	Low	Degraded habitat.
15-25%	Medium	Increased pollutant loads, toxic materials, and water temperatures.
25-50%	High	Higher peak flows. Impaired stream chemistry, biology
50%+	Severe	Severe changes in hydrology, hydraulics, morphology, water quality. Few natural attributes remaining.

<u>Specific to the Lower Fall Creek Watershed</u>

Within the Lower Fall Creek Watershed, the continued growth of the Indianapolis Metropolitan Area has greatly influenced land use and land use change. As recent as 50 years ago, the area outside of I-465 was primarily agricultural with some scattered, low-density residential development. However, these areas have, and continue to, rapidly urbanize. The most dramatic change has occurred in the Town of Fishers. As shown in **Figure 2-3** and **Figure 2-4**, almost the entire area in the Lower Fall Creek Watershed has been developed. Thirteen of the 20 fastest growing municipalities in Indiana are in the Indianapolis Metropolitan Area, including the Town of Fishers, the City of Lawrence, and the City of Noblesville in the Lower Fall Creek Watershed.

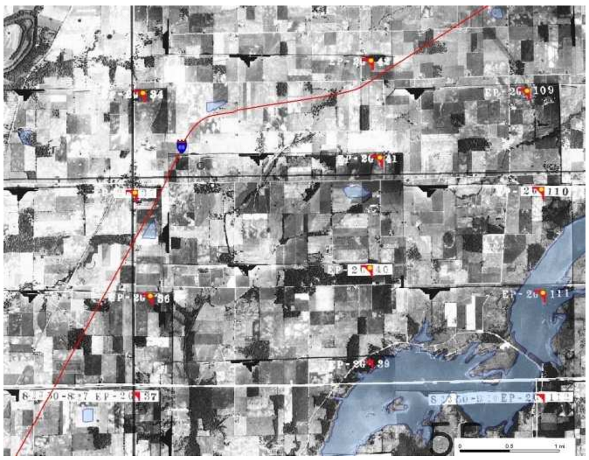


Figure 2-3: Fishers 1950

Figure 2-4: Fishers 2003

Recognizing the recent growth and anticipated continued growth in the Lower Fall Creek Watershed, the Land Use & Economic Development Work Group created a unique land use map that combines similar land uses based on their risk to water quality. Rather than displayiing generic land use classifications such as residential, commercial, industrial, etc., the Work Group combined the land uses in the Lower Fall Creek Watershed into 7 categories:

1. *Agriculture*: Land used for cultivation of crops, pasturage, horticulture, animal husbandry with necessary buildings for housing and storage:
2. *Low-density Residential*: Single family suburban development on ½ acre or larger lots; public water and sewer facilities may or may not be present; large mowed or wooded lots and paved streets connecting individual homes;
3. *Commercial, Industrial, Educational, Medium-to-High Residential*: Subruban and urban development with greater than 75% imperviousness, no NPDES permit; typical of neighborhood commercial districts, general commercial districts, high intensity commercial districts, and commercial-industrial districts; public water and sewer facilities required; single family residential development on ¼ acre lots; multi-family townhouses, condomimiums, and high-rise apartments in proximity to schools and businesses; extensive network of streets, rooftops, parking lots, and on-street parking;
4. *Commercial, Industrial*: development greater than 75% imperviousness, NPDES permit, listed on IDEM's Community Right to Know due to type and quantity of potentially harmful materials stored and handled on-site; includes light, medium, and heavy industry (based on amount of dirt, noise, glare, odor, etc.); large buildings, parking, and depending on use, outdoor storage;
5. *Open Space*: active and passive recreational uses, nature preserves, greenway corridor; limited imperviousness (access road, parking, paths, and park facility); fertilizer application dependent on use;

6. *Golf Courses*: public and private golf course facilities; limited imperviousness (access road, parking, paths, and club house); exentsive fertilizer application to maintain greens; and
7. *Active Construction*: development in progress regulated under IDEM Rule 5 program requiring erosion and sediment control practices .

Exhibit 2-2 illustrates these land use categories in the Lower Fall Creek Watershed.

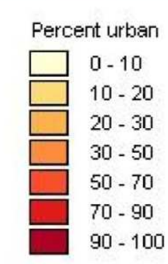
In an effort to address how the land uses in the Lower Fall Creek Watershed were changing, the Land Use & Economic Development Work Group created a Land Use Influences map. This map, shown in Exhibit 2-2, illustrates areas of anticipated growth and development, including the Town of Fishers, the City of Noblesville, and the Town of McCordsville. The Work Group identified 2 significant land use changes including the redevelopment of former commercial and industrial land into Bio Crossroads, at the confluence of Fall Creek and White River and the 700-acre Corporate Campus and Saxony Development at Exit 10 in the City of Novblesville (north of I-69) and Town of Fishers (south of I-69). Other areas of proposed or anticipated land use change include the proposed Technology Park Development at Exit 5 in the Town of Fishers, proposed residential and commercial development of Wayne Township in the City of Noblesville, the proposed airport south of Lapel, the Mt. Comfort Airport in Hancock County, the proposed McCord Square Develpoment in the Town of McCordsville, as well as the influence and proximity of I-69 and I-74 in the Lower Fall Creek Watershed.

<u>Central Indiana Growth Models</u>

In 2003, the Indiana University-Purdue University Indianapolis Center for Urban Policy and the Environment released the Land Use in Central Indiana model (LUCI) for planners, policymakers, and citizens to explore the implications of policy choices and alternative assumptions on future development patterns. According to literature from the Center, LUCI predicts the conversion of non-urban land to urban use, the general development pattern, and the resulting population density through 2040.

The Land Use & Economic Development Work Group used LUCI to predict 2040 land use for 3 growth scenarios:

1) Current Growth Model – maintain current density, limited restriction on sensitive lands, some restrictions on agricultural lands, no urban growth boundaries, current dispersal of development, proximity to existing utilities not required
2) Build-Out Growth Model – decrease density, no restriction on sensitive lands, no restrictions on agricultural lands, no urban growth boundaries, more dispersed development, proximity to existing utilities not required
3) Conservation Growth Model – minimum density, restriction on sensitive lands (wetlands, riparian buffers, steep slopes, forested areas), restrictions on agricultural lands,



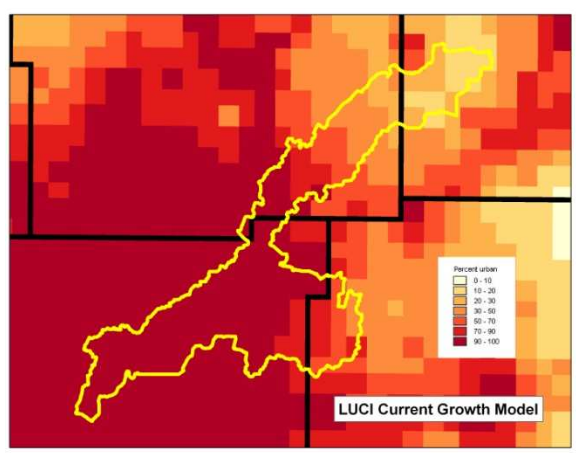


Figure 2-5: LUCI 2040 Current Growth Model

establish an urban growth boundary, less dispersed development, access to existing utilities required

Figure 2-5, **Figure 2-6** and **Figure 2-7** illustrate the result of these 3 growth models. As shown in **Table 2-3**, the percentage of each land use in the Current and the Conservation Growth Models are similar. However, as shown in Figure 2-3 and Figure 2-5, the distribution is very different. Not surprisingly, the Build-Out Growth Model shows an increase in residential, commercial, industrial, and educational development in lieu of agricultural land uses.

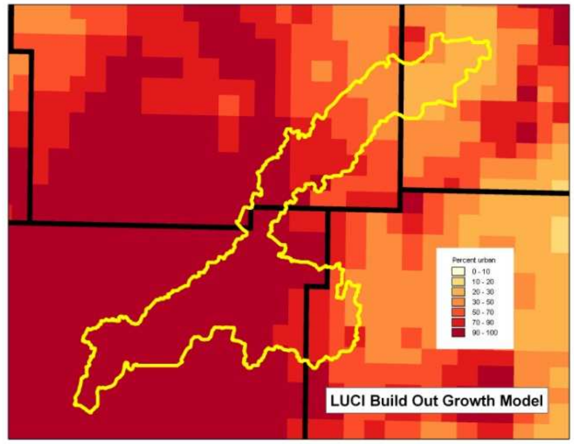


Figure 2-6: LUCI 2040 Build-Out Growth Model

The 2040 land uses from the LUCI growth models were entered into Purdue University's Long-Term Hydrologic Impact Assessment (L-THIA) tool to determine the impact of each scenario on water quality. L-THIA was designed to help community planners, developers, and citizens quantify the impact of land use change on the quantity and quality of water. The following summarizes the results from L-THIA:

- Average Annual Runoff Volume – increase (10%) in Build-Out Growth Model and 5% increase in urbanized portion of Conservation Growth Model
- Nutrient Loading – significant decrease (74%) in nitrogen and phosphorus in Build-Out Growth Model (eliminated agricultural land uses); slight decrease (2%) in Conservation Growth Model
- Sediment Loading – significant decrease (77%) in suspended solids in Build-Out Growth Model (eliminated agricultural land uses); minimal decrease (0.5%) from Conservation Growth Model
- Pathogen Loading – significant increase (194%) *fecal streptococcus* in Build-Out Growth Model (greatest increases associated with residential land uses); 15% increase in Conservation Growth Model

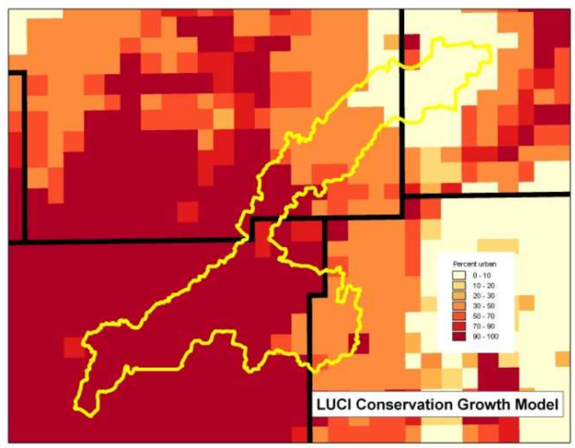


Figure 2-7: LUCI 2040 Conservation Growth Model

Table 2-3: Current and Projected Land Use

Land Use	Local Data & Aerials	LUCI GROWTH MODEL 2040		
		Current	Build-Out	Conservation
Agricultural	38.5%	37.7%	0.0%	31.6%
Low-Density Residential	32.4%	22.5%	49.0%	24.2%
Commercial, Industrial, Educational, Medium to High-Density Residential [1]	19.8%	30.8%	43.4%	35.3%
Commercial, Industrial [2]	0.5%			
Open Space	5.9%	8.9%	7.6%	8.8%
Golf Course	2.3%			
Rule 5	0.6%	NA	NA	NA

[1] greater than 75% imperviousness
[2] greater than 75% imperviousness; NPDES Permit, Community Right to Know

Recommendations & Discussion

The municipalities in the Lower Fall Creek Watershed have invested significant time and resources into developing a Comprehensive Plan and Ordinance(s) that are unique to how they wish to see their community grow and develop in the future. These documents are important in that they determine the location density, and design of development (and redevelopment). However, these documents do not always consider the impact of land use and land use change on water quality (and quantity), causing communities to work harder to meet regulatory requirements such as NPDES Phase II, TMDLs for impaired streams, drinking water standards, compensatory flood storage, and ultimately quality of life.

In 2008, the Center for Watershed Protection published “Managing Stormwater in Your Community”. Chapter 3 of this document is dedicated to the land use planning and water quality/quantity. **Table 2-4** highlights land use planning strategies that should be considered to protect and enhance water resources.

Table 2-4: Land Use Planning Strategies

Watershed Characteristics	Land Use Planning Strategy
Special receiving water	• Overlay zoning and performance standards • Conservation development • Special stormwater criteria • Low impact development
Existing flooding problem	• Overlay zoning and performance standards • Special stormwater criteria • Low impact development • Street design • Fee-in-lieu program
Impaired stream	• Special stormwater criteria • Special use permits for certain uses • Performance standards • Low impact development • Conservation development

(CWP, 2008)

There has been a growing interest of utilizing green infrastructure to filter sediments and pollutants from stormwater before it drains to receiving waters. Many local governments and groups associated with protecting surface water resources have begun to investigate and incorporate Low Impact Development (LID) techniques into their planning and development regulations. LID principles include:

- Minimizing stormwater impacts to the extent practicable through reducing imperviousness, conserving natural resources and ecosystems, maintaining natural drainage courses, reducing use of pipes, and minimizing clearing and grading;
- Providing runoff storage measures dispersed uniformly throughout a site's landscape with the use of a variety of detention, retention, and runoff practices;
- Maintain predevelopment time of concentration by strategically routing flows to maintain travel time and control the discharge; and
- Implementing effective public education programs to encourage property owners to use pollution prevention measures and maintain the on-lot hydrological functional landscape management practices.

2.3 RELATIONSHIP OF GROUNDWATER & SURFACE WATER

Groundwater Concerns

Groundwater resources and Wellfield Protection Areas (WFPAs) should be an important consideration during the development and implementation of the WMP. A WFPA is the land above and surrounding wells drilled into an aquifer where the water seeps into the ground and recharges the aquifers from which the wells extract water. Typically these WFPAs are divided into two areas of concern, the 1-year and 5-year times of travel. These areas are based on the amount of time needed for groundwater to reach the well.

Under natural hydrologic conditions, a large percentage of stormwater is allowed to infiltrate the soil and recharge the groundwater resources. As indicated in **Figure 2-8** the amount of infiltration and groundwater recharge is diminished as more development and more impervious surface is added to the watershed landscape.

Within central Indiana, some of the most productive aquifers follow the major river systems of White River, Eagle Creek, and Fall Creek. With this in mind, it is very important to know if a stream or river is a gaining stream or a losing stream. In **Figure 2-9**, the top illustration indicates how the gaining stream is fed by groundwater resources. This provides the base flow for this stream. In the bottom illustration, the losing stream provides groundwater recharge as water is lost from the stream into the water table.

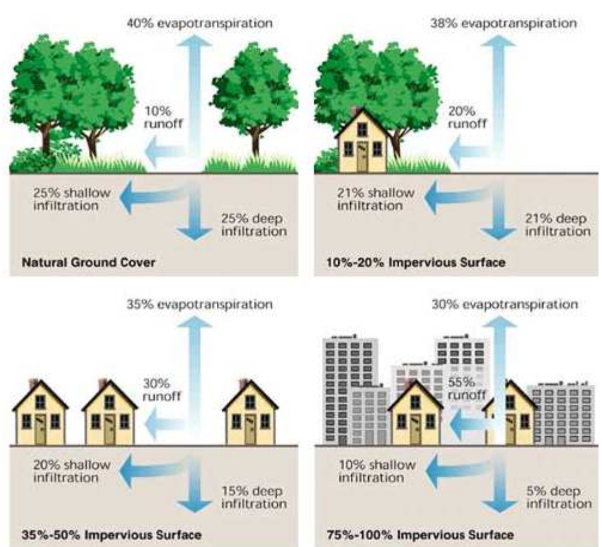


Figure 2-8: Infiltration and Imperviousness

If streams and rivers are losing streams, the potential for groundwater contamination is greater and planning efforts should account for this increased risk. Unfortunately, within the Lower Fall Creek Watershed, this information is not readily available. It is not known at this time if Fall Creek and its tributary streams are gaining or losing streams. Hydrologic information, especially as it pertains to drinking water sources, has become sensitive information and is not readily shared between agencies and offices.

Primary pollutants of concern regarding WFPAs include:

- Nutrients – especially nitrates in cool, wet weather due to reduced de-nitrification, volatilization, limited microbial action, and plant uptake
- Pesticides – can be in high concentrations in dry flows such as those related to landscape irrigation
- Pathogens – especially near CSO areas
- Metals – Aluminum, Copper, Iron, Lead, and Nickel can be present in stormwater runoff
- Salts – Ice prevention and removal treatments can cause high concentrations in snow melt and runoff
- Pharmaceutical & Personal Care Products – recent studies have shown that 93% of USGS Groundwater samples contained low levels of steroids, nonprescription drugs, and/or insect repellants.

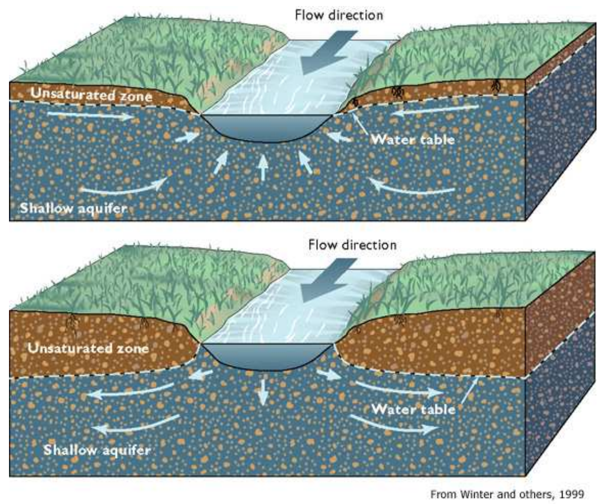


Figure 2-9: Gaining (top) and Losing (bottom) Streams

Specific to the Lower Fall Creek Watershed

In the Lower Fall Creek Watershed, approximately 25% of the watershed is designated as a WFPA. It is estimated that 20% of the Central Indiana population is serviced by the wells protected by the WFPAs. Rural residents within the Hancock and Madison County portions of the watershed are primarily serviced by private residential wells. The WFPAs within the Lower Fall Creek Watershed are indicated on **Figure 2-10**.

The City of Indianapolis has adopted a Wellfield Protection Zoning Ordinance with zoning classifications W-1 for the 1-year time of travel and W-5 for the 5-year time of travel areas. Within these areas, all new site development plans must be reviewed by a Technically Qualified Person (TQP) to ensure that groundwater resources will be protected and that the facility does not pose and unreasonable risk to the groundwater. Restrictions and requirements to ensure this risk is lowered include connections to sanitary sewers, covering of areas where maintenance will occur, and secondary containment for chemical storage areas.

The Marion County Wellfield Education Corporation (MCWEC) was developed as part of the Wellfield Protection Zoning Ordinance to prevent contamination of the groundwater resource through public awareness and education – targeting pre-existing commercial and industrial businesses in the WFPAs. MCWEC maintains a Potential Source Inventory (PSI) database for each wellfield (a list of existing and potential sources of contamination within the WFPAs which might represent a threat to the public water supply system), visits each facility to discuss groundwater issues, and conducts confidential detailed on-site assessments for interested business owners. Through the efforts of MCWEC, Marion County has been designated as a Groundwater Guardian Community by the National Groundwater Foundation since 1998.

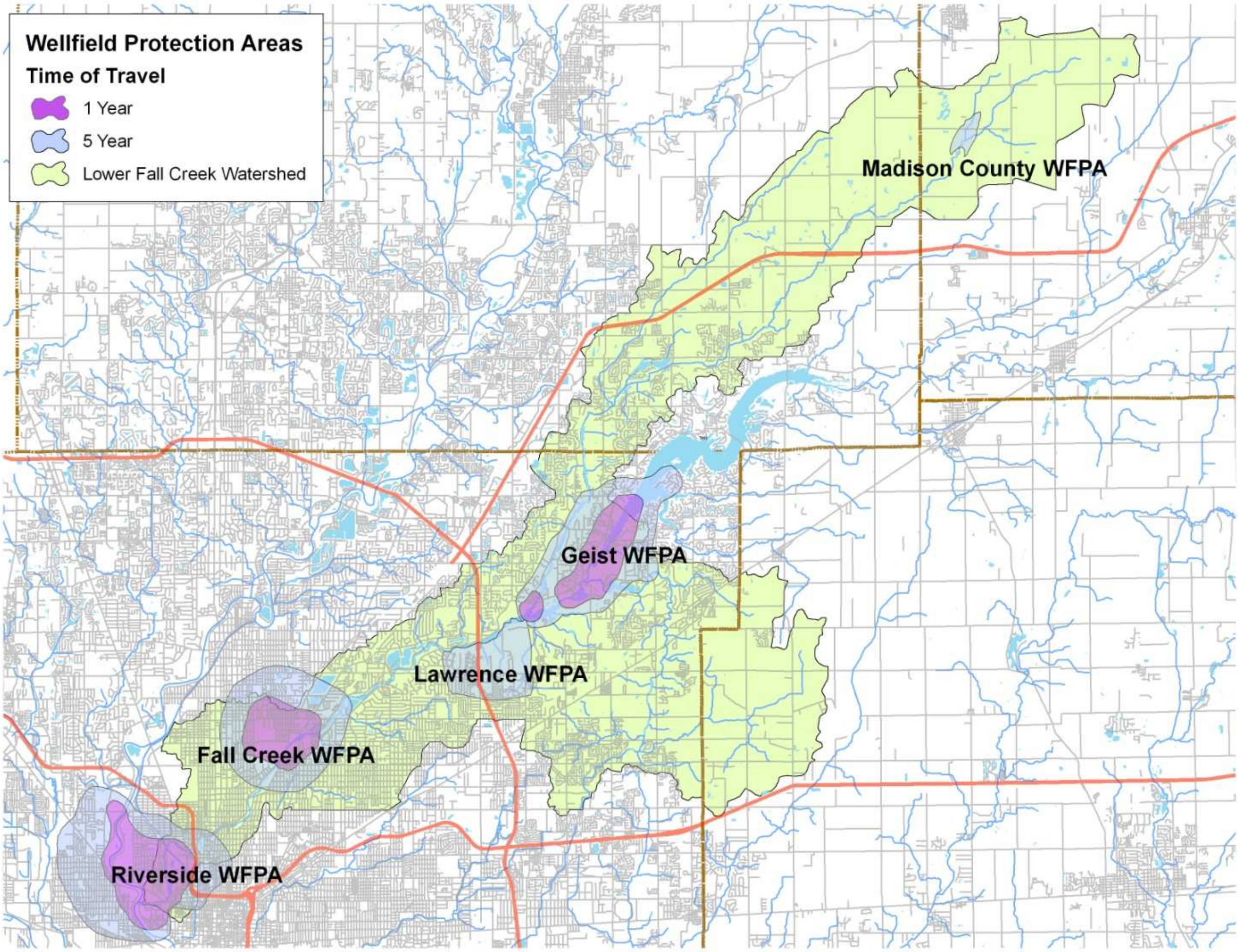


Figure 2-10: Wellfield Protection Areas

According to the PSI database, the Riverside WPFA has 175 facilities with chemicals stored or handled on-site that, if mishandled, could potentially contaminate the groundwater. More than half of these are within the W-1 or 1-year time of travel. MCWEC considers the Riverside WFPA as their highest priority because of the large number and age of the commercial and industrial facilities. The Fall Creek WFPA has 112 facilities (52 in the W-1). The land use of the Fall Creek WFPA has a mix of commercial, industrial, educational, and high-density residential land uses. Further upstream, in the Lawrence and Geist WFPAs, the land use transitions to residential, open space, and some commercial. Both of these wellfields have significantly fewer facilities of concern. Lawrence has 11 active facilities identified on the PSI (none in the W-1) and Geist has 4 facilities listed with 2 in the W-1. The Madison County WFPA is in currently in agriculture production. An ordinance to regulate land uses in this WFPA has not been adopted.

Surface Water Concerns

Veolia Water utilizes surface water from Fall Creek to provide Indianapolis residents with clean, safe drinking water. Real-time water quality sampling takes place near the surface water intake on Fall Creek. These samples are tested for over 90 parameters on a monthly basis. According to Veolia representatives, phosphorus reductions in the ambient surface water in Fall Creek would serve to reduce the treatment efforts and process required to treat the water.

Issues of debris, such as litter and uprooted trees are also a concern, as these can restrict flow and clog intake pipes creating a concern for both water quantity and water quality. Algal blooms, such as those occurring in Geist Reservoir in 2007 and 2008, create taste and odor problems that have affected the drinking water quality for years. To address the algal blooms, remote sensing technologies have been employed to better detect, map, and characterize the blooms which lead to a decrease in the number of taste and odor complaints. Further, by utilizing these technologies, chemicals used to treat algal blooms have decreased from 9,000 pounds to 900 pounds annually. In 2002, Veolia entered into a long-term partnership with the Center for Earth and Environmental Science at IUPUI to conduct applied research targeted at both protecting and improving water quality.

Recommendations and Discussion

LID techniques can be important to protecting surface water quality and may be utilized to protect groundwater quality as well. However, infiltration techniques such as vegetated swales, bio-retention areas, and porous pavements on commercial or industrial properties within the WFPAs may pose a threat to groundwater resources.

Therefore within the 1-year time of travel, it may be best to limit infiltration practices such as vegetated swales and small bio-retention areas to residential or other low intensity land uses. Demonstration BMPs such as these may be placed on individual residential lots, in common areas throughout neighborhoods, or in open areas on school properties. School properties may provide the best partnership opportunity as BMPs such as vegetated swales, rain gardens, or small bio-retention facilities can be utilized for educational purposes as well and these properties typically allow for high accessibility and visibility. Within the 5-year time of travel, infiltration practices may also be utilized on smaller commercial properties and higher intensity residential facilities, such as multi-family dwellings and apartment complexes.

2.4 FLOODING & FLOODING IMPACTS

Flooding is defined as an inundation of land by the rise and overflow of a body of water caused by heavy rainfall and/or melting ice and snow, increased imperviousness, floodplain encroachment, deforestation, stream obstruction, or failure of a flood control structure. Flooding can result in widespread impacts in both rural and urban areas. Impacts of flooding include: damage to property and inventory; damage to utilities/disruption of service; impassible roads and bridges; injuries, fatalities, mental/physical stress; degradation of water quality; and channel/riparian modification.

Floodplains are lands adjacent to streams, rivers, and creeks that combine to form a complex, dynamic physical and biological system. When portions of floodplains are preserved in (or restored to) their natural state, they provide many benefits to both human and natural systems. Floodplains can provide temporary storage for floodwaters, provide ideal settings for wetlands, improve water quality, offer green space that can be used as buffers, greenways or other functions, and provide important habitat for wildlife.

Flooding can be expected to occur in the floodplain or Special Flood Hazard Area (SFHA). **Figure 2-11** illustrates a plan view and cross section of a floodplain.

The terms are defined as:

- Floodway – essential part of stream conveyance system. It includes the stream channel plus adjacent floodplain area.
- Floodway Fringe – the area subject to flooding by the regulatory or base flood. The regulatory or base flood is defined as an area with a 1% or greater annual probability of flooding also known as the 100-year flood.

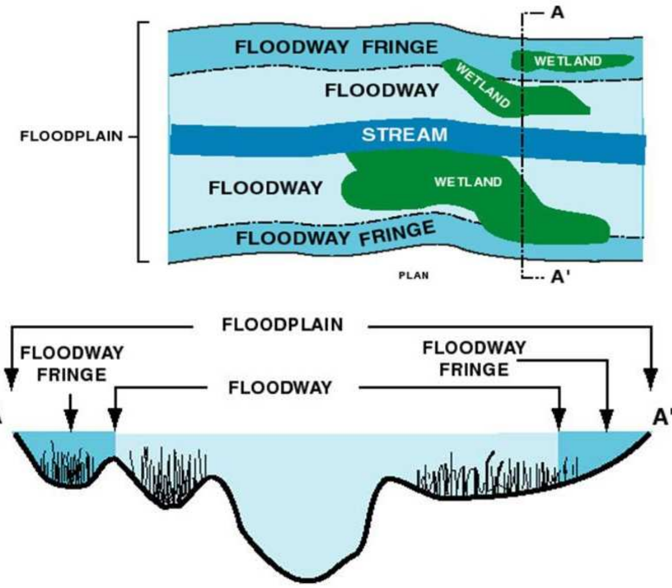


Figure 2-11: Floodplain Areas

Flooding may also occur outside of the floodplain area as a result of increased urbanization relying on antiquated or undersized drainage systems that are unable to deal with the increase volume and velocity of stormwater. The increased volume and velocity of water can be detrimental to receiving streams resulting in severe erosion, scouring, and undercutting of streambanks and ultimately loss of aquatic and terrestrial habitat. Runoff associated with floodwaters may carry extremely toxic substances such as gasoline, oil, and pesticides that results in downstream deterioration of water quality.

Specific to the Lower Fall Creek Watershed

According to FEMA's most recent Flood Insurance Rating Maps (FIRMs), Fall Creek, Grassy Creek, Mud Creek, and Sand Creek are the only waterways that have been studied in detail and base flood elevations have been determined (**Figure 2-12**). The remaining waterways are unstudied or classified as Unnumbered Zone a streams which means the base flood elevations have only been approximated.

In the Lower Fall Creek Watershed, development in the floodplain is regulated through local Floodplain Ordinances. Each local ordinance is based on the State of Indiana Model Floodplain Ordinance and states that 1) no development in the SFHA shall create a damaging or potentially damaging increase in flood heights or velocity or threat to public health and safety and 2) all buildings to be located in the SFHA shall be protected from flood damage below the flood protection grade (elevation of the regulatory flood plus 2 feet at any given location in the SFHA). The City of Indianapolis (includes City of Lawrence), City of Noblesville, Town of Fishers, Hamilton County, and Hancock County all participate in the Community Rating System (CRS) of the National Flood Insurance Program (NFIP). This program provides reduced flood insurance premiums to participating communities that go above and beyond the minimum NFIP requirements.

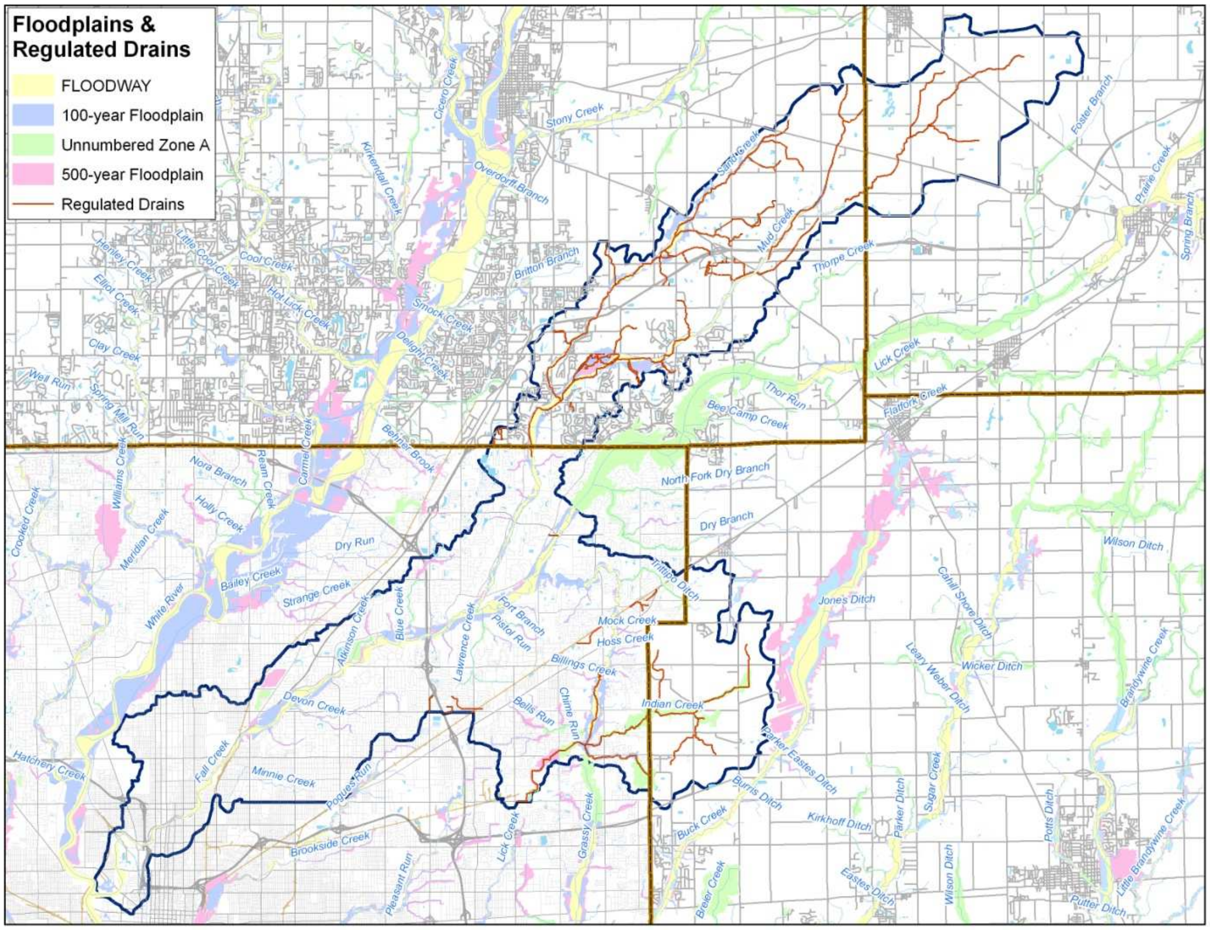


Figure 2-12: Floodplains and Regulated Drains

Hamilton County, Town of Fishers, City of Noblesville, Town of McCordsville, and Hancock County have each adopted Stormwater Management Ordinances that includes a No Net Loss Floodplain/Compensatory Storage Policy. This policy is above and beyond the minimum Floodplain Ordinance requirements. Compensatory storage is required when a portion of the floodplain is filled, occupied by a structure, or when as a result of a project a change in the channel hydraulics occurs that reduces the existing available floodplain storage. Compensatory storage should be located adjacent or opposite the placement of the fill and maintain an unimpeded connection to an adjoining floodplain area.

Maintenance of waterways, including clearing fallen trees, log jams, and debris is essential to maintaining stream flow during high water and reduce flooding. Approximately 60% of the waterways in the Lower Fall Creek Watershed are regulated drains. A regulated drain can be an agricultural drain, urban storm sewer, or open ditch. As shown in Figure 2-12, these are primarily located in Hamilton, Madison, and Hancock County and under the jurisdiction of the local Drainage Board. In Marion County, the City of Indianapolis DPW is responsible for regulated drains. Land owners within the drainage area of a regulated drain pay for maintenance and reconstruction based on an assessment process. Maintenance of non-regulated drains is the responsibility of adjacent landowners. The SWCD in each county and the IDNR Division of Water is able to provide some guidance on stream maintenance to individual landowners.

Flood complaints are tracked and addressed in each county by the Surveyor's Office, Indianapolis DPW, and SWCDs. In the Lower Fall Creek Watershed, there have been few flood complaints in the headwaters in Madison County and Hamilton County. In Hancock County, flood complaints have been documented by residents along the Trittipo Ditch. In Marion County, flood complaints are tracked through the Mayor's Action Center.

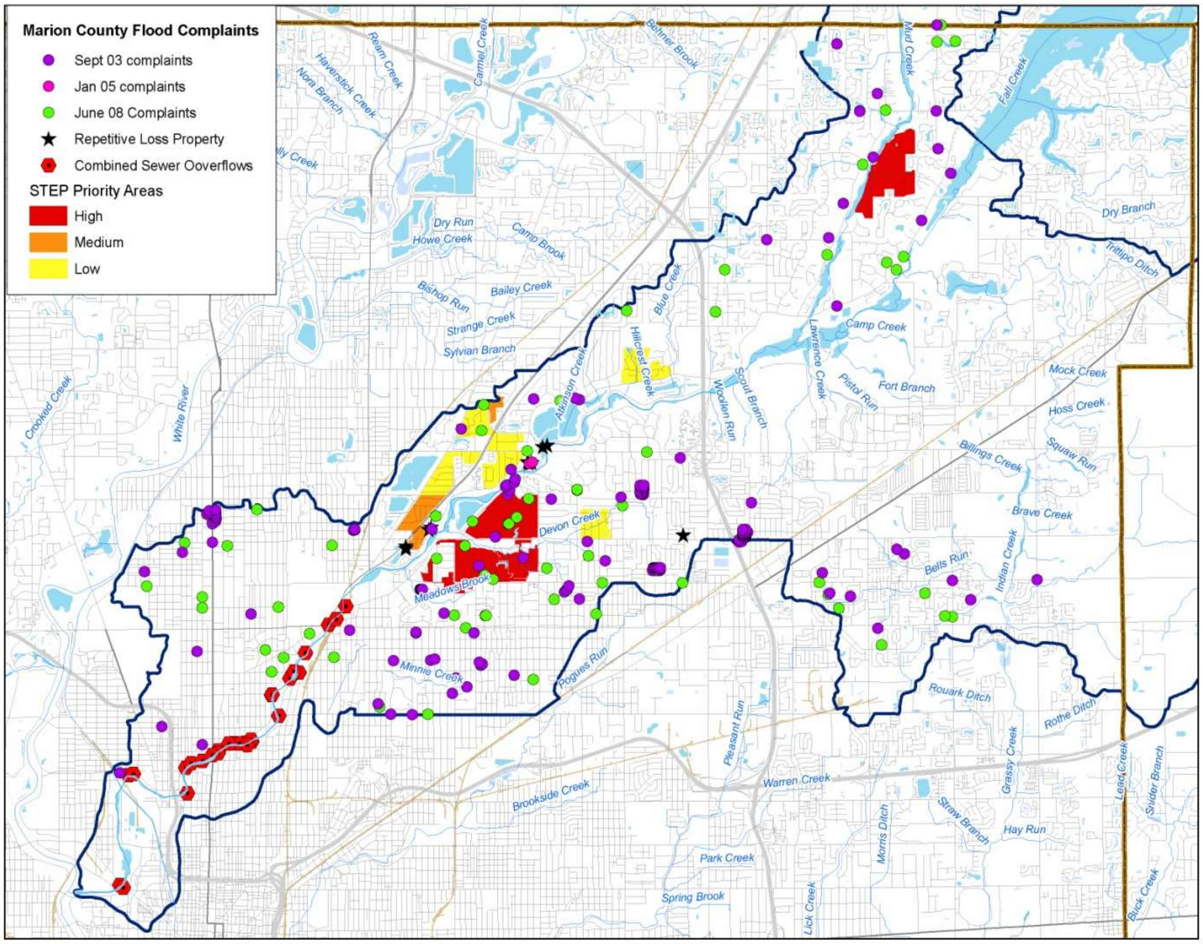


Figure 2-13: Flood Complaints

Figure 2-13 illustrates flood complaints in the Lower Fall Creek Watershed during the last 3 significant rain events: September 1, 2003, January 3, 2005, and June 7, 2008. A number of flood complaints were received outside of the regulatory floodplain and were attributed to the storm sewers, open ditches, and small tributaries. These systems were trying to convey larger volumes of water from more impervious area than they are typically designed for. Flood complaints were also documented in priority Septic Tank Elimination Program (STEP) areas of the Lower Fall Creek Watershed. During a flood or heavy rainstorm, excessive water can accumulate in the leach field and cause the septic system to become sluggish, back up, or stop functioning. Raw sewage may accumulate on the ground or get washed into receiving waters and result in long-term water quality problems.

Recommendations and Discussion

The impacts of flooding and flood-related losses can be greatly reduced through better design and planning. LID has been discussed as a method to improve water quality and reduce flood storage areas (for smaller rain events only). **Figure 2-14** (top) illustrates a typical stormwater management practice of draining the entire site to a single pond and a large volume of water leaving the site. The bottom of Figure 2-14 shows the LID technique that uses small stormwater infiltration and retention facilities distributed throughout the site to capture rainfall and reduce the volume of water leaving the site. This technique reduces the volume and velocity of water to conveyance systems (storm sewers, open ditches) as well as improving the water quality that does make its way to the receiving waters.

Figure 2-14: Low Impact Development

Although flooding complaints along the regulated drains have been minimal, these conveyance systems could be modified into 2-stage ditches to store and filter floodwater in the headwaters of the watershed and reduce the impact of flooding in the downstream urban areas.

Flood-related losses could be reduced by understanding actual flood depths along unstudied or unnumbered Zone A streams. This would ensure that new buildings are elevated above the regulatory floodplain and existing structures could be protected from flood damage. Flood-related losses could also be reduced through improved flood warning systems like additional stream gages on Mud Creek (Hamilton County) and Indian Creek (Hancock County). This will become increasingly important to the City of Indianapolis and the City of Lawrence as the upstream communities of the City of Noblesville, Town of Fishers, and Town of McCordsville continue to grow and less land is available to retain floodwaters.

Many of these issues are further detailed and potential mitigation measures are included in existing plans developed such as the Multi-Hazard Mitigation Plans developed for each of the 4 counties, the City of Indianapolis Flood Response Plan, and the Community Rating System (CRS) programs developed by Hamilton County, Hancock County, the City of Indianapolis, and the City of Noblesville.